# Engineering Case Studies

## Introduction

In an effort to improve the quality of project applications, engineering case studies have been prepared for several common mitigation measures. The engineering cases studies provide focus on the types of information and data needed to ensure completeness of the sections of the project application affecting engineering feasibility. Of particular importance in the engineering review are:

- Scope of Work, including:
  - Problem Description and Proposed Solution;
  - Description of Existing Condition; and,
  - Work Schedule.
- Cost Estimate, including:
  - Conducting the Benefit-Cost Analysis;
  - Anticipated environmental resource remediation or historic property treatment measures;
  - Engineering schematics, detailed engineering drawings, or engineering designs;
  - Other related construction/demolition/relocation costs, such as survey, permitting, site preparation, material disposal; and,
  - Other related acquisition costs, such as appraisals, legal recordation, displacement costs for renters, maintenance.

For each of these sections in the project sub-application, the engineering case studies describe the general type of information that a Sub-applicant should submit. In order to provide additional guidance, the case studies also include sections of a sample project application that present the kind of specific information that the Sub-applicant would need to include in each engineering-related section to support the proposed project. These engineering case studies are not meant to represent complete project applications. Some relevant project information related to historic and environmental impacts, as well as information regarding the project's cost effectiveness may not be included.

The types of projects presented in the following engineering case studies are:

1. Minor Structural Flood Control Projects,
2. Elevation,
3. Acquisition, and
4. Wind Shutters.

The types of projects listed represent some of common mitigation measures; however, the general information provided in these case studies as well as the manner in which they are presented, could apply to various mitigation project applications.

## Case Study #1 - Minor Structural Flood Control Projects

Generally, minor structural flood control projects mitigate future flood damages by modifying the runoff characteristics in a specific project area. The projects can include a wide variety of activities including, but not limited to increasing the capacity of a storm sewer system, construction of a new detention facility, alteration of an existing drainage facility, or construction of a floodwall. Although the specific design and relevant project data vary depending on the specifics of the mitigation activity proposed, the general type of information required in a complete grant application is similar. The following sections describe in detail the information required and provides a sample for each application section.

### Scope of Work

The proposed mitigation activity should be well defined, with a clear and detailed written description of the entire scope of work. Technical documentation should be provided verifying that the proposed project successfully reduces future flood levels and associated future flood damages. In addition, the anticipated level of project effectiveness should be stated as clearly as possible. Detailed technical back-up information should be included with the scope of work description, including but not limited to the following:

- Describe in detail the project that is being proposed;
- Include any studies, schematics, or construction plans that will help give details of the proposed project;
- Include a site map clearly showing the location of all proposed project components and their location relative to the areas of historic damage within the contributing watershed;
- Include any hydrologic and/or hydraulic calculations or models that support the proposed mitigation by clearly demonstrating the decrease in future flood levels and associated future flood damage;
- Show that any NFIP requirements have been addressed (i.e. fill in the special flood hazard area (SFHA);
- Describe and quantify any potential downstream effects from the proposed project; and,
- Include any state or local stormwater design codes or standards that need to be followed, including design flows, rainfall frequencies, freeboard, water surface, changes in water surface elevation, allowable velocities, etc.

### *Sample Scope of Work*

*The proposed project is to replace the undersized 60-inch corrugated metal pipe (CMP) under Main Street with a 70-foot long double 5-ft x 5-ft concrete box culvert with erosion control protection placed at both the inlet and the outlet of the culvert. ABC Engineers, Inc. has prepared a preliminary design report that includes the hydrologic (USACE HEC-1 model) and hydraulic (Culvert Master) back-up calculations used to size the new structure. The report includes existing and proposed water-surface elevations upstream of the culvert for various storm recurrence intervals. The analyses show that with the existing culvert in place, the 5-year storm overtops the road. The new culvert was designed to pass the ultimate conditions 50-year peak runoff discharge with a headwater elevation of 108.25, allowing 18-inches of freeboard below the road shoulder (109.8). This design is based on the road culvert standards required per the 2002 County Public Facilities Manual (applicable sections are attached to the application). Once construction is complete, the frequent storm events will no longer overtop Main Street.*

## Case Study #1 - Minor Structural Flood Control Projects (Continued)

***Sample Scope of Work (Continued)***

*The new box culvert will be constructed parallel to the existing CMP, and the existing culvert will be removed once the new box culvert is constructed. All state erosion and sediment control procedures will be followed during construction. A schematic of the proposed culvert is included in the engineers report. Because the Main Street crossing of Swift Creek is in a SFHA, all NFIP requirements will be met. As shown on the attached watershed drainage map, Swift Creek flows through undeveloped county property into the Big River approximately 500 feet downstream of the road crossing; so downstream effects from the new box culvert are expected to be inconsequential. Due to the local terrain, Main Street is not impacted by flood events along the Big River.*

**Problem Description and Proposed Solution**

A detailed written description of the history of flooding that has occurred at the project location should be provided and should include the following information:

- Describe in detail the source of flooding (e.g. riverine, coastal, local drainage, etc.) and provide any explanation of the cause of flooding. (e.g. pre-FIRM construction, increased upstream development, inadequate drainage capacity of flooding source, etc.);
- List the history of previous flood events including dates, extent and magnitude of impacts, photos of historic flooding, overall cost of damages, and the estimated frequency of each specific event;
- If the facility is in a FEMA SFHA, list the corresponding flood depths and discharges from the Flood Insurance Study (FIS) for the various storm recurrence intervals;
- Briefly state the proposed solution;

***Sample Problem Description And Proposed Solution***

*There have been repetitive flood damages to Main Street due to the undersized 60-inch diameter CMP culvert along Swift Creek. As a result of the increase in development in the upstream watershed over the years, the culvert no longer has the capacity to pass the flow during large storm events causing Swift Creek to overtop Main Street, closing the road to traffic. Main Street is a high-traffic-volume road in the community and is one of the main access routes to the Hospital. If Main Street is shut down, the response time of emergency vehicles to the southern portion of the community is greatly increased. A city street map is attached with the application highlighting the location of the culvert. Also attached are photos of road overtopping that occurred during the June 17, 2002 storm event. That storm was determined to be a 10-year event.*

*Post-flood maintenance and repair costs, including repavement of the road surface, regrading of the eroded gravel shoulders and road embankment, cleanup of debris washed onto the road surface and within the channel upstream of the culvert and repairs to the CMP culvert have cost the community over $215,000 in the past 20 years. Force-account material and labor records for repairs after 15 different flood events are summarized in a table included with the application.*

## Case Study #1 - Minor Structural Flood Control Projects (Continued)

***Sample Problem Description And Proposed Solution (Continued)***

*The proposed project is to replace the undersized 60-inch CMP under Main Street with a double 5-ft x 5-ft concrete box culvert, which will allow the runoff from a 50-year storm event to pass through the culvert without overtopping the road. Swift Creek is included on the County FIRM panel 00135 as a special flood hazard area Zone AE. Selected portions of the 1987 FEMA Flood Insurance Study - including the FIRM panel, stream profile and Summary of Discharges table - are included with the application.*

**Description of Existing Conditions**

The existing conditions within the project area should be described in detail and should include the following:

- Describe existing flow conditions including stream characteristics, system/watershed inlet and outlet locations;
- Provide a detailed description of all infrastructure including, but not limited to size, inverts, materials, conditions, dates of construction, etc.;
- Describe the watershed including current and proposed land use, topography of the area, and areas upstream or downstream that are impacted by the existing facility.

***Sample Description of Existing Conditions***

*Main Street was originally constructed in 1965. When the road was widened in 1983, the length of the 60-inch CMP was increased from 45 to 75 feet. The construction drawings completed for the 1983 widening project are included with the application. The drawings show the as-built details of the culvert. The invert of the culvert was paved during the 1983 construction to increase the flow capacity. The design calculations for the original or the extended culvert could not be located. The culvert and wingwalls have been inspected and maintained over the years. The construction joint between the original and extended culvert has held up fairly well, but frequent maintenance has been required to keep the connection from separating. Current photos of the construction joint, the culvert entrance and exit, the upstream and downstream channel and the general area have been labeled and included in the application.*

*The 110-acre watershed drainage to the culvert has become urbanized over the years, causing significant increases in runoff during storm events. The channel grade of Swift Creek varies from steep in the upper portions to moderate around the Main Street crossing. In response to the rapid growth in County development in the mid 1990s a watershed study was prepared by ABC Engineers, Inc. for the county in 1997. The study determined the existing and ultimate hydrologic conditions of selected watersheds and calculated water-surface elevations for various recurrence intervals for the major streams. The study showed that the existing conditions headwater elevation for the 5-year storm is 110.5, which is one-half foot overtop of the low point of the road (elevation 110). A copy of this report has been attached to this application.*

*As stated in the Problem Description, flood-related damages to Main Street at the crossing of Swift Creek are becoming more frequent with the new upstream development. In addition, a townhouse development on the upstream side of the road experienced high water levels and basement flooding during the June 2002 storm.*

**Case Study #1 - Minor Structural Flood Control Projects (Continued)**

**Work Schedule**

Additional supporting documentation for the project should include a work schedule to:

- Describe the anticipated project schedule;
- Include all phases of the task including survey, design/specifications, construction, permitting, site preparation, etc.;
- Include a description of any potential changes or obstacles that may be encountered during project implementation.

***Sample Work Schedule***

| | *Calendar days from Award* | | |
|---|---|---|---|
| *Task* | *Start* | *Complete* | *Total Days* |
| *Engineering and Secure Final Design Plan Approval* | *0* | *90* | *90* |
| *Permitting* | *90* | *120* | *30* |
| *Prepare Bid Documents and Advertise for Bids* | *90* | *150* | *30* |
| *Award Construction Contract* | *150* | *170* | *20* |
| *Construct Project* | *170* | *230* | *60* |
| *Project Closeout* | *230* | *260* | *20* |
| | | *Total to Complete Project* | *260* |

*This schedule is based on the assumption that the project construction phase will fall within the normal construction season. Should this phase occur between the months of November and March, construction may be delayed accordingly.*

**Cost Estimate**

All anticipated project costs should be detailed, including maintenance costs over the useful life of the project. Avoid the use of lump sum costs. Whenever possible, quantify or provide additional breakdown of large lump sum costs items. The Cost Estimate should include the following:

- Provide the source of the estimate (e.g. documented local cost, bids from qualified professionals, published national or local cost estimating guides, etc.) and provide documentation supporting each source;
- Reference the base year of all cost estimates provided, and consider any potential deviations due to the anticipated date of construction;
- Make sure costs include the likely date of construction.

## Case Study #1 - Minor Structural Flood Control Projects (Continued)

***Sample Cost Estimate***

***CULVERT REPLACEMENT***

| *ITEM DESCRIPTION* | *UNIT* | *QUANTITY* | *UNIT PRICE* | *AMOUNT* | *SOURCE* |
|---|---|---|---|---|---|
| *Mobilization* | *LS* | *1* | *$5,000* | *$5,000.00* | *Engineer* |
| *Remove Ex. Asphalt* | *SY* | *125* | *$4* | *$500.00* | *Means* |
| *Remove Ex. 60" Rcp* | *LF* | *75* | *$10* | *$750.00* | *Means* |
| *Remove Ex. Wingwall And Headwalls* | *EA* | *2* | *$1,000* | *$2,000.00* | *Means* |
| *Load, Haul And Dump Removals, 5mi Rt* | *CY* | *10* | *$325* | *$3,250.00* | *Means* |
| *Relocate Existing Utilities* | *LF* | *100* | *$60* | *$6,000.00* | *Engineer* |
| *Excavation* | *CY* | *500* | *$5* | *$2,500.00* | *Means* |
| *Headwall And Wingwall* | *EA* | *2* | *$2,000* | *$4,000.00* | *Means* |
| *Double 5'x5' Box Culvert* | *LF* | *70* | *$560* | *$39,200.00* | *Means* |
| *Erosion Control Stone* | *TON* | *150* | *$15* | *$2,250.00* | *Engineer* |
| *Road Reconstruction* | *LF* | *20* | *$1,000* | *$20,000.00* | *Engineer* |
| *Erosion And Sediment Control* | *SF* | *500* | *$10* | *$5,000.00* | *Engineer* |
| *Subtotal* | | | | *$90,450.00* | |
| *Engineering Design and Construction Inspection @ 10.0%* | | | | *$9,045.00* | |
| *TOTAL* | | | | *$99,495.00* | |
| *TOTAL FEDERAL SHARE* | | | | *$74,621.00* | |

*Means = RS Means Site Work and Landscape Cost Data, 2003*
*Engineer = Mr. John Smith of ABC Construction Company*

## Case Study #2 – Elevation

One of the most common mitigation methods is to elevate a flood prone structure so that First Floor Elevation (FFE) is above a desired design flood elevation (DFE). When the property falls within a FEMA designated Special Flood Hazard Area (SFHA), the DFE is commonly established by the Base Flood Elevation (BFE), which is determined from the FEMA Flood Insurance Study (FIS). The goal of these projects is to elevate all living or occupied space above the level of all but the most severe flood events. This can be accomplished by a number of methods including elevating the entire structure on the existing foundation, constructing a new structural foundation, or abandoning living space below the DFE and replacing it with new construction at a higher elevation. Although many of these methods can vary significantly in approach, the general information required for a complete grant application is fairly similar. The following sections describe in detail the information required, and provides samples for each application section.

### Scope of Work

The proposed elevation activities should be well defined and technical documentation should be provided verifying that the scope of work will successfully protect the structures against future flood damages up to the design flood elevation. Detailed technical information should be provided in the scope of work description, including the following.

- Describe the elevation technique being employed for each structure to be elevated.
- If possible include calculations for all applicable loads (live, dead, lateral, soil, wind, flood and scour) particularly for structures in SFHA V zones.
- Describe the new foundation type. Show pile or pier configuration, loads and connection details.
- State what elevation the first floor of the structure will be raised to, and its relation to the BFE and/or storm surge elevations.
- Show that all NFIP requirements have been addressed.
- Include any Federal, State or Local building codes or standards that need to be followed (e.g. FEMA 347).

***Example Scope of Work***

*The elevation of all 11 projects included in this project application will be completed so that the FFE of each structure is one foot above the BFE. As stated above, the BFE throughout the project area is 9 feet NGVD. Therefore all properties included in this project will be elevated to a minimum elevation of 10 feet NGVD. As a condition of being included in the project application, property owners were required to submit conceptual design documents prepared by a qualified structural engineer. Because all structures are currently constructed on a crawl space, all projects will be completed by elevating the structure, constructing a new pier foundation, and placing the structure on the newly constructed foundation. Detailed descriptions of the foundation design for each structure, including site schematic drawings and structure photos have been included as an attachment to this application. All NFIP codes and standards will be incorporated into the project design, and will be enforced by the County Building Department. The work will be completed by the lowest competitive bid from a local qualified construction firm.*

**Case Study #2 – Elevation (Continued)**

**Problem Description and Proposed Solution**

A detailed written description of the history of flooding that has occurred at the project location should be provided and should include the following information.

- Describe in detail the source of flooding (e.g. riverine, coastal, local drainage, etc.) and provide any explanation of the cause of flooding. (e.g. pre-FIRM construction, increased upstream development, inadequate drainage capacity of flooding source, etc.)
- List the history of previous flood events including dates, extent and magnitude of impacts, photos of historic flooding, overall cost of damages, and the estimated frequency of each specific event.
- If the facility is in a FEMA Special Flood Hazard Area (SFHA), list the corresponding flood depths and discharges from the Flood Insurance Study (FIS) for the various storm recurrence intervals.
- Briefly state the proposed solution, which will be described in detail in the scope-of-work section.

***Example Problem Description And Proposed Solution***

*The Suburban residential neighborhood has experienced frequent and significant flooding since its development in the late 1950's. The Suburban neighborhood is bounded by the Bay on the east and south, by 1st Avenue on the west, and by Main Street on the north. A detailed map of the area, as well as a map depicting its location within the community, has been attached.*

*Minor flooding in this area occurs on a nearly annual basis, while significant flooding has occurred approximately 6 times since it's development in the late 1950's. The last significant flood event occurred on September 6th and 7th of 1999, when floodwaters associated with Tropical Storm ABC reached an elevation of 9.1 feet National Geodetic Vertical Datum (NGVD) in the Bay. Over 30 structures in the area were inundated with floodwaters due to this event, with some receiving up to 3 feet of floodwaters in the first floor of the structure. The elevated waters cut off access to the neighborhood for over 2 days and some families were not able to return to their homes for up to three weeks. The total damage from Tropical Storm ABC, in the Suburban neighborhood alone, was over $1 million dollars. The attached spreadsheet titled "Suburban Damage History" includes a record of all recorded flood events in this area, and includes the date of the event, maximum flood elevation, estimated return frequency, number of structures impacted, average damage per structure, and total damage in the neighborhood.*

*There are approximately 60 residential properties located within this area, virtually all of which have experienced flooding during moderate to significant coastal storms. The average grade elevation in the area is approximately 6 feet NGVD. With no seawall or other flood protection structure, floodwaters enter the neighborhood when the tide elevations in the Bay exceed the grade elevation. According to the FEMA Flood Insurance Study for the community, completed in 1992, the entire project area is located in a SFHA Zone A, with a BFE of 9feet NGVD. The table of flood frequencies and corresponding tide heights for the Bay have been included as attachments to this application.*

*This project proposes that 11 of the residential structures located in the impacted area of the Bay be elevated so that the FFE of each structure is one foot above the BFE of 9 feet NGVD.*

**Case Study #2 – Elevation (Continued)**

**Description of Existing Conditions**

The facility(ies) being elevated should be listed. The following information should be included in the property description of the application.

- List the number of properties or facilities that are being elevated.
- Describe the primary use of the facilities (e.g. single family residential, public library, commercial).
- If residential, state if the property is owner-occupied, rental or seasonal.
- Provide a detailed description of the facility including: foundation type (e.g. slab-on-grade, crawl space, underground basement), construction type (e.g. wood frame, masonry, concrete), square footage, age, value of structure, condition, first floor elevation (elevation certificate), etc.
- List the damages that have occurred to the facility for various storm events and the costs associated with those damages. Include a history of flood insurance claims made for each property if possible.
- If the property is commercial or industrial, the owner must provide information identifying what, if any, hazardous materials are known to exist within the facility that may require special handling or measures (e.g. fuel tanks, etc.).

***Example Description Of Existing Conditions***

*There are 11 residential structures located in the impacted area of theBay that are proposed to be elevated. The locations of the 11 homes are indicated on the community street map enclosed with the application. Eight of the homes are owner-occupied, two are rental properties, while one is a seasonal property. All of the structures are wood frame construction with a crawlspace built in the late 1950's. The average grade elevation of the homes included in the elevation project is approximately 6 feet NGVD. A property list is attached including the property type (residential, non-residential), construction date, photo of each structure, value of structure (obtained from County Clerk and Recorder's Office property records); and Finished Floor Elevations (FFE) for each structure. In addition, a copy of the tax assessor's sheet for each property and a FEMA-approved elevation certificate for each structure have been included. The Elevation Certificates have been prepared prior to the submission of this application by the County survey crew.*

**Work Schedule**

Additional supporting documentation should include a work schedule to:

- Describe the anticipated project schedule.
- Include all phases of the task including: survey, design/specifications, construction, permitting, site preparation, etc.

***Example Work Schedule***

*The anticipated project schedule for the proposed project is included below. This schedule has been prepared for a typical structure included in this application. The schedule for each individual property may vary based on site specific conditions. The complete elevation program will be completed within 18 months of project approval.*

**Case Study #2 – Elevation (Continued)**

***Example Work Schedule (Continued)***

| *Description of Task* | *Starting Point* | *Unit of Time* | *Duration* | *Unit of Time* |
|---|---|---|---|---|
| *Property Survey* | *0* | *Month* | *1* | *Months* |
| *Bid Proposal and Award* | *1* | *Month* | *3* | *Months* |
| *Permitting and Contracting* | *4* | *Month* | *2* | *Months* |
| *Site preparation* | *6* | *Month* | *1* | *Months* |
| *Elevation* | *7* | *Month* | *4* | *Months* |
| *Site grading and Landscaping* | *11* | *Month* | *1* | *Months* |

**Cost Estimate**

- Make sure all anticipated elevation project costs are detailed.
- Provide the source of the estimate (e.g. documented local cost, bids from qualified professionals, published national or local cost estimating guides, etc.)
- Consider the potential future date of construction when compiling the cost estimate.

***Example Cost Estimate***

*Actual construction estimates have been completed for each structure included in the project application. Property owners have been required to submit a cost estimate, completed by a qualified structural engineer prior to inclusion in the program. Detailed summaries of the cost estimates have been included in the Project Cost Summary Table attached. In addition, copies of the cost estimate provided for each structure have also been included. Based on the cost estimates provided, the total project cost for this project is $528,000, with a federal share of $396,000.*

## Case Study #3 – Acquisition

Removing structures and infrastructure from hazardous areas is one of the most effective forms of mitigation. Commonly this is accomplished by acquiring hazard prone properties and either demolishing or relocating any structures located in these hazardous areas. Once the structures have been removed, deed restrictions are prepared for each property, restricting the use of the property as open space in perpetuity. Typically structures eligible for acquisition are ones that have repetitive damages due to flooding or are threatened by other impending natural hazards such as landslides. For this case study, riverine flooding is the hazard.

### Scope of Work

The proposed mitigation activity should be well-defined. For acquisition projects the scope of work is relatively straight-forward. The following information should be included within the scope of work description.

- List the number of each type of structure or property that is to be acquired. Include maps to clearly indicate the location of the facilities to be acquired.
- Describe how these homes have been selected, the level of the property owner commitment to this project, and the proposed approach for the acquisition process.
- State if there are any State or Local codes or standards that need to be followed (i.e. for removal of hazardous materials).
- Provide a statement or documentation certifying that the property will remain as open space in perpetuity.

***Example Scope of Work***

*Wrightsville has identified 30 home acquisition within this area for this acquisition project, and has identified this project as its number one priority for mitigation in the community. The project is titled the "Creekbank Subdivision Residential Buyout". Wrightsville will oversee the construction aspects of the project. The community's GIS has been utilized to prepare a map which depicts the FEMA-identified 100-year floodplain for Swift Creek on the most recent version of an orthophoto quad dated October 2001. A copy of the map is attached to the application as an electronic file.*

*A public meeting was held on March 23, 2003 at which homeowners were presented with the details of the proposed mitigation project, and interest in participating in the program was solicited. Subsequent to that meeting, 30 homeowners in this area have contacted the County expressing interest in participating in the program should funding become available, and submitted a letter of interest, of which copies are attached. Once a homeowner expressed written interest in the program, the County authorized a certified appraiser to conduct and appraisal on the property based on comparable properties in the area, in pre-flood condition in order to determine the properties' Fair Market Value (FMV). These appraisals have been included as an attachment to the project application, and will serve as the basis of the cost estimate for this project.*

**Case Study #3 – Acquisition (Continued)**

***Example Scope of Work (Continued)***

*Once the properties have been acquired, all structures located and on these properties will be demolished by County contractors, and materials disposed in the County owned and operated landfill. It is possible that some, if not all, of the structures being proposed for acquisition contain asbestos insulation. Costs have been allocated for asbestos inspection fees for each of the 30 residential structures. If asbestos is detected, remediation will be necessary prior to demolition. The Township Housing Authority (THA) has a dedicated fund for environmental impact resolution. Full funding will be made available to the project for remediation, if necessary. See attached funds commitment letter from the THA Executive Director.*

*The total land area of the 30-home subdivision is 7.2 acres. This land will be dedicated to open space use in perpetuity by deed restriction and recorded with River County. The subject area will be graded and re-claimed with native ryegrass. When the properties have been acquired, recorded deed restrictions for each property will be provided to the state and FEMA, if needed.*

*Long-term maintenance of the property, which will ultimately be owned by the Township, will include landscape/lawn care. These costs will be budgeted annually by the community. (See attached letter from Township Board of Directors). The project also provides one unrelated, but important, benefit. The open space will enhance the viewscape of the Downtown Area Historic District. Ownership of the subject property by the Township will be recorded with the River County Clerk and Recorder.*

**Problem Description and Proposed Solution**

A detailed written description of the history of flooding and the characteristics of the flood problem that has occurred at the project location should be provided and should include the following information.

- Describe in detail the source of flooding (e.g. riverine, coastal, local drainage, etc.) and provide any explanation of the cause of flooding. (e.g. pre-FIRM construction, increased upstream development, inadequate drainage capacity of flooding source, etc.)
- List the history of previous flood events including dates, extent and magnitude of impacts, photos of historic flooding, overall cost of damages, and the estimated frequency of each specific event.
- If the facility is in a FEMA Special Flood Hazard Area (SFHA), list the corresponding flood depths and discharges from the Flood Insurance Study (FIS) for the various storm recurrence intervals.
- Briefly state the proposed solution, which will be described in detail in the scope-of-work section.

**Case Study #3 – Acquisition (Continued)**

***Example Problem Description And Proposed Solution***
*The Creekbank Subdivision was built in 1965-67, prior to the community's participation in the National Flood Insurance Program (NFIP). Flood maps were first produced for the community in 1978 and revised for Swift Creek in 1999. The community has experienced flooding events on Swift Creek in 1969, 1976, 1988, 1992, 1996 and 2000. Photos of flooding during the 2000 storm event are included with the application. A community street map is included highlighting the location of the houses impacted by flood events. Upstream development may be contributing to increased flows on Swift Creek as more areas are paved over and natural flood storage areas are diminished.*

*The project area is located on the east bank of Swift Creek in Zone A1 on FIRM panel 10083D0003E dated May 3, 1999. Selected portions of the Flood Insurance Study – including the FIRM panel, stream profile and Summary of Discharges table are included as an electronic file.*

*A recent field report (attached) prepared by XYZ Engineering, Inc. has determined that the 30 target properties in the Creekbank Subdivision are now impacted by flooding when the 10-year flood event occurs. Average flooding depths are 0.5 feet above the 10-year flood elevation. These elevations were field verified by the XYZ Engineering survey department, and FEMA-approved elevation certificates were prepared. These elevation certificates are attached to the application as scanned electronic files.*

*This project proposes to acquire these 30 homes and dedicate the land to open space use as part of the community's ongoing flood control mitigation efforts.*

**Description of Existing Conditions**
The facility(ies) being acquired should be listed. The following information should be included in the property description of the application.

- List the number and location of properties or facilities that are being acquired. Provide a detailed map indicating their location.
- Describe the primary use of the facilities (e.g. single family residential, public library, commercial).
- If residential, state if the property is owner-occupied, rental or seasonal.
- Provide a detailed description of the facility including: construction type, square footage, age, value of structure, foundation type, condition, first floor elevation (elevation certificate), etc.
- List the damages that have occurred to the facility for various storm events and the costs associated with those damages. Include a history of flood insurance claims made for each property, if possible.
- If the property is commercial or industrial, the owner must provide information identifying what, if any, hazardous materials are known to exist within the facility that may require special handling or measures (e.g. fuel tanks, asbestos, medical wastes, etc.), and the owner must remove any such materials and obtain a clean-site certification from the appropriate state agency.

**Case Study #3 – Acquisition (Continued)**

***Example Description of Existing Conditions***
*There are 30 residential structures located in the 100-year floodplain of Swift Creek. Twenty-four of the homes are owner-occupied, while six are rental properties. The buildings being acquired are masonry construction with slab-on-grade foundations built between 1965 and 1967. Average first floor elevations at the project site are 0.5 feet above the 10-year flood elevation based on water surface elevations taken from the community's Flood Insurance Study (FIS). (See attached electronic file). All 30 structures in the subdivision are required by their lenders to carry flood insurance. The written premium for these structures through the NFIP totals $9,750 annually*

*Electronic attachments include: 1) property type (residential, non-residential), age and value of structure obtained from County Clerk and Recorder's Office property records (scanned paper copies), 2) Base Flood Elevation data included as a table and estimated by XYZ Engineering from the community FIRM, which has been overlaid on 1"=100' orthophoto quad using GIS (map attached), and 3) finished floor elevations, included on FEMA-approved elevation certificates, for each structure based on field surveys conducted by XYZ Engineering's survey crew.*

**Work Schedule**
Additional supporting documentation should include a work schedule to:

- Describe the anticipated project schedule
- Include all phases of the task including: survey, appraisals, legal offers, closing, permitting, demolition, site preparation, etc.

***Example Work Schedule***
*The estimated duration for all phases of the acquisition project is thirty (30) months according to the schedule, below.*

| *Description of Task* | *Starting Point* | *Unit of Time* | *Duration* | *Unit of Time* |
|---|---|---|---|---|
| *Property Survey* | *0* | *Month* | *1* | *Months* |
| *Appraisals* | *1* | *Month* | *1* | *Months* |
| *Purchase offers, closing costs, Legal fees* | *2* | *Month* | *24* | *Months* |
| *Asbestos Survey* | *26* | *Month* | *1* | *Months* |
| *Demolition Plan, Permitting and Contracting* | *27* | *Month* | *1* | *Months* |
| *Site preparation* | *28* | *Month* | *1* | *Months* |
| *Demolition* | *29* | *Month* | *1* | *Months* |
| *Grading and Landscaping* | *29* | *Month* | *1* | *Months* |

**Case Study #3 – Acquisition (Continued)**

**Cost Estimate**

- Make sure all anticipated acquisition costs are detailed.
- Costs should be included for, at a minimum, the following tasks: site assessment, surveys, permitting, appraisals, legal recordation, property acquisition, displacement costs for renters, hazardous material inspection, structural demolition or relocation, management, and administration.
- Provide the source of the estimate (e.g. documented local cost, bids from qualified professionals, published national or local cost estimating guides, etc.)
- Consider the potential future date of construction when compiling the cost estimate.

***Example Cost Estimate***

*As stated previously, property appraisals have been completed for all properties included in this application, and the acquisition fees for these properties have been based on these appraisals. A summary of these appraisals is included in the Property Data summary table attached, and individual copies of each appraisal are also included as attachments. Additional costs for this project include legal fees and closing costs, site demolition costs, and asbestos inspection. These costs have been estimated by local contractors and are included in the following cost estimate table. In addition, documentation of each unit cost as submitted from the appropriate resource has also been attached.*

| *Item Name* | *Cost Classification* | *Unit Quantity* | *Unit of Measure* | *Cost Estimate ($)* |
|---|---|---|---|---|
| *Phase 1 Site Assessment* | *Miscellaneous* | *1.00* | *Lump Sum* | *$ 5,000.00* |
| *Site Preparation Prior to Demolition* | *Preliminary expense* | *1.00* | *Lump Sum* | *$ 12,000.00* |
| *Subdivision and Survey* | *Architectural engineering basic fees* | *1.00* | *Lump Sum* | *$ 4,000.00* |
| *Permits* | *Construction and project improvement* | *1.00* | *Lump Sum* | *$ 3,000.00* |
| *Write-up and recordation of deed restrictions* | *Miscellaneous* | *1.00* | *Lump Sum* | *$ 4,000.00* |
| *Property and Improvements Acquisition* | *Land, structures, right-of-way* | *30* | *Appraised Values* | *$ 1,560,000.00* |
| *Demolition* | *Demolition and removal* | *1.00* | *Lump Sum* | *$ 312,000.00* |
| *Site Grading and Landscaping* | *Construction and project improvement* | *1.00* | *Acre* | *$ 15,000.00* |
| *Spec's, Contracting and Construction Inspection* | *Architectural engineering basic fees* | *1.00* | *Lump Sum* | *$ 60,000.00* |
| *Asbestos inspection fees* | *Miscellaneous* | *1.00* | *Lump Sum* | *$ 10,000.00* |

| *Item Name* | *Cost Classification* | *Unit Quantity* | *Unit of Measure* | *Cost Estimate ($)* |
|---|---|---|---|---|
| *Contract Administration* | *Administrative expense* | *1.00* | *Lump Sum* | *$ 60,000.00* |
| *Certified Appraisal Fees* | *Miscellaneous* | *1.00* | *Lump Sum* | *$ 5,000.00* |
| *Legal and Accounting Fees* | *Administrative expense* | *1.00* | *Lump Sum* | *$ 10,000.00* |
| **Total Cost Estimate** | | | | **$ 2,060,000.00** |

*Total Cost Estimate is $ 2,060,000, with a proposed Federal share of $ 1,545,000.*

*Attached supporting documentation includes:*

- *XYZ Engineering - Asbestos inspection, Subdivision and survey, Specifications, contracting and construction inspection*
- *ABC Hauling and Demolition, Inc. - Site Preparation Prior to Demolition, Demolition; Site Grading and Landscaping*
- *Township – Contract administration; Legal and accounting fees; Write-up and recordation of deed restrictions; Permits*
- *MNOP Appraisal Service - Certified Appraisal Fees and Property Appraisal Sheets*

## Case Study #4 – Wind Shutters

One of the most common wind mitigation methods is the installation of wind shutters on structures. Wind shutters installed over windows and other openings protect buildings and contents from the damaging effects of hurricanes and other high wind events; however, shutters are not typically designed to protect buildings against extreme wind events such as strong or violent tornadoes. Typically, wind shutters are constructed of wood, plastic, or metal, and are most effective for facilities along or near the coast that are subject to frequent hurricanes and other high wind storms. Although wind shutter materials and systems can vary, the general information required for a complete grant application is fairly uniform. The following sections describe in detail the information required, and provides samples for each application section.

### Scope of Work

The proposed construction activities should be well-defined and technical documentation should be provided verifying that the scope of work will successfully protect the structures against future high wind damages. Detailed technical information should be provided in the scope of work description, including the following.

- Describe the shuttering technique being employed for each structure to be protected. Also, specify if the entire building, or only parts of the building such as shelter areas, will be receiving shutters.
- Include wind design properties (e.g. Exposure Category, Enclosed building, Importance Factor) and calculations for applicable wind loads.
- State what maximum wind speed or storm class the structure will be designed to withstand.
- State what maximum wind speed the shutters will be designed to withstand, including any applicable standards (e.g. SSTD 12, ASTM E 1996).
- Include any Federal, State or Local building codes or standards that need to be followed (e.g. FEMA 361).

***Example Scope of Work***

*The proposed shutter project will consist of a steel roll-down shutter system covering the entire 1,800 square feet of exterior window area. The shutter system includes electric motors to allow them to be lowered automatically; however, the shutters can still be lowered manually in the event of a power outage. The existing school was designed as an enclosed building with an Importance Factor of 1.15 and Exposure Category C, and the building structure (including all doors) was originally designed and constructed to withstand a 90-mph fastest mile design wind. However, no wind design was incorporated into the design of the building envelope and currently no windows are protected from wind pressures and windborne debris.) The shutter system will be designed to withstand positive and negative wind pressures associated with wind speeds up to 110 miles per hour, and resist debris impact forces in accordance with SSTD 12. An engineering analysis of the existing school building indicates that adding the shutter system will reduce structural wind damages from a Category 2 Hurricane (wind speed range 96-110) by 80 percent and provide partial protection from Category 3 and 4 storm events. (The analysis also confirmed that the building elements around the windows can withstand the forces transferred from the shutter system to the building.) Refer to the attached design calculations for additional details.*

**Case Study #4 – Wind Shutters (Continued)**

**Problem Description and Proposed Solution**

A detailed written description of the wind hazard potential and past damages that have occurred at the project location should be provided and should include the following information.

- Describe the source of high winds (e.g. hurricanes, tropical storms, etc.) and provide any known explanation of the cause of the hazard (e.g. large windows or other openings, inadequate or no shutter protection, etc.)
- List the history of any previous wind damage events including dates, extent and magnitude of impacts, photos of historic wind events, overall cost of damages, and the estimated frequency of damaging wind events.
- Provide information on the wind design of the current building, building code at the time of construction, on high wind design requirements for the location (if applicable), and what proposed standards will be met or exceeded.
- Provide the location of the facility, including distance from the coast, and indicate if the facility is located in a FEMA Special Flood Hazard Area (SFHA).
- Briefly state the proposed solution, which will be described in detail in the scope-of-work section.

***Example Problem Description And Proposed Solution***

*The City Middle School is located in the Town. A detailed map, showing the location of the school within the community, is attached. Although the school building is located outside the 500-year floodplain, it has sustained wind damage from several hurricanes and tropical storms due to its close proximity to the Atlantic coast. A list of these windstorm events, along with a description of the damages and actual repair costs associated with each event, is attached.*

*An analysis of this information indicates that typical wind damages at the school have led to damages of equipment and costly disruptions to school operations. Over the past twenty-five years, the school building has been damaged by high wind events in 1985, 1993 and 2002.*

*This project proposes to reduce future wind damage at the City Middle School building by installing shutters to prevent contents damage and functional downtime caused by wind-driven rain entering through broken windows.*

**Description of Existing Conditions**

The facility(ies) being protected should be listed. The following information should be included in the property description of the application.

- List the number of properties or facilities are being protected.
- Describe the primary use of the facilities (e.g. single family residential, public library, commercial).
- If residential, state if the property is owner-occupied, rental or seasonal.
- If public, indicate if the facility is used as a hurricane evacuation shelter, and include any State required facility surveys and/or checklists in accordance with American Red Cross Standards (ARC 4496, ARC 3041, ARC Form 6564).

**Case Study #4 – Wind Shutters (Continued)**

**Description of Existing Conditions (Continued)**

- Provide a detailed description of the facility including: foundation type (e.g. slab-on-grade, crawl space, underground basement), roof type (e.g. flat gravel ballast roof on corrugated metal supported by steel trusses, asphalt shingles on plywood supported by timber trusses, construction type (e.g. engineered or non-engineered wood frame, masonry, manufactured), square footage, age, building construction codes and standards (if any), value of structure, condition, number of stories, etc.
- List the damages that have occurred to the facility for various high-wind events and the costs associated with those damages. Include a history of insurance claims made for each property if possible.

***Example Description of Existing Conditions***

*The proposed mitigation project is for protection of the City Middle School building; a publicly-owned facility which serves approximately 1,200 students and 100 faculty and staff in the Town of City during the school year. The school also provides summer school classes to an average of 200 students and staff in the greater City area as well as adult education classes on evenings and weekends throughout the calendar year. The City Middle School also serves as a shelter for up to 1,000 local residents in severe storm events. It is important to note, since the building lacks sufficient shutter protection in the designated shelter areas, it does not currently meet the American Red Cross Standards for hurricane evacuation shelters (ARC 4496). A Red Cross Facility Survey (ARC Form 6564) conducted in January 2003 is attached.*

*The City Middle School building is a two-story, slab-on-grade reinforced masonry structure constructed in 1978. The school was engineered and constructed in with the basic provisions of the Standard Building Code (SBCCI), and a 2002 inspection report by the City Public Works Department indicates that the building is in fair condition. The 14,000 square-foot school building has a flat membrane roof system supported by a corrugated metal deck and steel trusses which are anchored to the reinforced masonry walls. According to the City Department of Education, the City Middle School has an estimated building replacement value of $2.1 million (not including an estimated $2 million in contents) and an annual operating budget of $3.5 million.*

*The City Middle School has approximately 1,800 square feet of exterior openings that are covered by large plate glass windows. An analysis of damages from the three previous wind events that have impacted the school (in 1985, 1993 and 2002) indicate that the vast majority of wind damages at the school building can be attributed to failure of these windows. A list of these wind storm events, along with a description of the damages and actual repair costs associated with each event, is attached. Typically, broken glass windows have allowed wind-driven rain to enter the school classrooms, resulting in significant damages to contents and equipment and delays in school operations as repairs are made.*

**Case Study #4 – Wind Shutters (Continued)**

**Work Schedule**

Additional supporting documentation should include a work schedule to:

- Describe the anticipated project schedule.
- Include all phases of the task including: survey, design/specifications, construction, permitting, site inspection and preparation, etc.

***Example Work Schedule***

*The anticipated project schedule for the proposed project is included below. This schedule has been prepared for the structure included in this application. The complete shutter project will be completed within 12 months of project approval with minimal disruption to school operations.*

| *Description of Task* | *Starting Point* | *Unit of Time* | *Duration* | *Unit of Time* |
|---|---|---|---|---|
| *Bid Proposal and Award* | *1* | *Month* | *1* | *Months* |
| *Permitting and Contracting* | *2* | *Month* | *2* | *Months* |
| *Site Inspection and Preparation* | *3* | *Month* | *1* | *Months* |
| *Construction* | *4* | *Month* | *3* | *Months* |

**Cost Estimate**

- Make sure all anticipated project costs are detailed.
- Provide the source of the estimate (e.g. documented local cost, bids from qualified professionals, published national or local cost estimating guides, etc.)
- Consider the potential future date of construction when compiling the cost estimate.

***Example Cost Estimate***

*Based on the cost estimate listed below, the total project cost for this project is $77,000, with a federal share of $57,750.*

***CITY MIDDLE SCHOOL SHUTTER SYSTEM PROJECT***

| ***ITEM DESCRIPTION*** | ***UNIT*** | ***QUANTITY*** | ***UNIT PRICE*** | ***AMOUNT*** | ***SOURCE*** |
|---|---|---|---|---|---|
| *Mobilization* | *LS* | *1* | *$4,000* | *$4,000.00* | *Contractor* |
| *Roll-Down Metal Shutters* | *SF* | *1,800* | *$20* | *$36,000.00* | *Manufacturer* |
| *Shutter Installation* | *SF* | *1,800* | *$10* | *$18,000.00* | *Contractor* |
| *Electric Motors And Controls* | *EA* | *4* | *$2,000* | *$8,000.00* | *Manufacturer* |
| *Motor And Control Installation* | *EA* | *4* | *$1,000* | *$4,000.00* | *Contractor* |
| *Subtotal* | | | | *$71,000.00* | |
| *Engineering Design and Construction Inspection @ 10.0%* | | | | *$7,000.00* | |
| ***TOTAL*** | | | | ***$77,000.00*** | |
| ***TOTAL FEDERAL SHARE*** | | | | ***$57,750.00*** | |

## Case Study #4 – Wind Shutters (Continued)

### *Example Cost Estimate (Continued)*

*Attached supporting documentation includes:*

- *Contractor costs for mobilization and installation of roll-down metal shutters, electric motors and controls from Construction Company*
- *Manufacturer costs for furnishing roll-down metal shutters, electric motors and controls from Wind Breaker Shutter Systems, Inc.*
- *Engineering Design and Construction Inspection costs from ASAP Engineering, LLC*